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Money Demand and the Role of Foreign Financial Variables: Evidence from Malaysia[#]

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Abstract: This paper estimates the effect of foreign financial variables on money demand in Malaysia. The study fits the bounds testing approach to cointegration on quarterly data over the period 1991-2005. The test finds a single cointegration relation among the variables. However, the results of FMOLS model indicate that the coefficients of real income, real exchange rate and foreign interest rate are correctly signed and significant at 1 per cent level. Additionally, the error-correction term which measures the speed of adjustment is correctly signed and significant at 1 per cent level, suggesting that approximately 26 per cent of total disequilibrium in real money demand was being corrected in each quarter in Malaysia.

Keywords: Money demand; financial variables; bounds test; cointegration test, FMOLS
JEL classification: E41, F41

1. Introduction

Since the work of Hamburger (1977) and Arango and Nadiri (1992), researchers have been busy attempting to unearth the precise influence of foreign financial variables on the demand for money. The inclusion of financial variables such as exchange rates and foreign interest rates in the formulation of money demand functions was an implicit recognition of the importance of other variables on the domestic demand for money. The effectiveness of monetary policy on domestic economy depends critically on whether the domestic exchange regime is fixed or flexible. The assertion by Mundell-Fleming that monetary policy is most effective under the floating exchange rate regime while fiscal policy is most effective under a fixed exchange rate regime, given capital mobility, underlines this fact. In this inter-dependent world, the effects of monetary developments such as foreign interest rate and exchange rates in one country may have unpredictable repercussions on the demand for money in another country. For example, in open economies where domestic and foreign moneys are regarded as imperfect substitutes, a rise in foreign interest rates would cause domestic residents to switch from domestic to foreign assets, resulting in capital outflows. This capital outflows would subsequently cause domestic currency to depreciate, generating an excess demand for domestic money balances. This process is in direct contradiction to the conventional wisdom that a flexible exchange rate system insulates economies from shocks that originate from abroad in addition to giving policy makers greater control over stabilising policies.

Although money demand function remains one of the over-researched topics in economics, the question of whether or not to include both domestic and foreign interest

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rates in the estimation of money demand function has not been conclusively resolved. A number of factors, ranging from simultaneous equation bias, sampling error, stochastic movement in the true underlying parameters, mis-specifications of the underlying models, multicollinearity among the regressors to the data insufficiency, are held culprit for unexpected results. For example, Darrat and Al-Mutawa (1996) blamed the insignificance of both domestic and foreign interest rates on the data employed and possible correlation between the two rates. Furthermore, in cases where foreign and domestic interest rates are included, the insignificance of the latter has been blamed on the possible correlation between the two. For example, Harb (2004) attributed the lack of cointegration between money, real income, real exchange rates and the two interest rates to possible correlation between the two interest rates. As a result, he abandoned the LIBOR he employed as a proxy for foreign interest rate variable and, instead, applied panel cointegration without the foreign interest rate after which he found that the variables became cointegrated.

In addition to the issue of the insignificance of interest rates, there is also discord over the expected signs of interest rate coefficients. Hueng (1998) expected and found a significant positive coefficient of foreign interest rate. In justifying his finding, Hueng argued "since domestic and foreign moneys are imperfect substitutes precisely through the fact that withdrawals of both currencies require time, it is optimal to increase the holding of domestic money and the number of foreign currency withdrawals when the opportunity cost of holding foreign currency increases" (Hueng 1998:28). Others such as Hamburger (1977), Darrat and Al-Mutaw (1996) and James (2005) found negative coefficients of the foreign interest rate variable, arguing that an increase in foreign interest rates causes domestic residents to switch from domestic to foreign financial assets. This persistent lack of consensus over which interest rates to include in money demand function estimation provides an important motivation behind finding an estimation technique such as the ARDL and FMOLS models capable of solving the data and serial correlation problems simultaneously.

The objective of this paper is to estimate the effect of financial variables in addition to the traditional domestic determinants on the demand for money using quarterly data from Malaysia over the period 1991-2005. The study employs the bounds testing approach to cointegration within an autoregressive distributed lag (ARDL) model (Pesaran 1997; Pesaran *et al.* 2001). The bounds testing techniques developed by Pesaran *et al.* (2001) possess a number of important advantages over alternative techniques such as the two-step residual-based cointegration procedure (e.g. Engle and Granger 1987) and the system-based cointegration approach (e.g. Johansen 1991; 1995). In the first place, the bounds test can be applied to test the existence of a relationship between variables in levels irrespective of whether they are purely $I(0)$, purely $I(1)$ or mutually cointegrated. In other words, the technique obviates pre-testing the order of integration among the variables. Second, the bounds testing technique can be applied to studies that employ small-size samples that are a common feature of data from many developing countries, unlike the other approaches. To ensure obtaining asymptotically efficient consistent estimators, fully modified ordinary least squares (FMOLS), proposed by Phillips and Hansen (1990), will be employed in tandem with ARDL model to tackle the problems of non exogeneity and serial correlation among regressors. We hope that employing FMOLS can solve the persistent presumed problem of correlation between domestic and foreign interest that undermines the necessary effect of domestic and foreign interest rates on money demand in money demand function models. The results of this study will certainly make this research a valuable contribution to the extant literature on money demand function. Therefore, we hope that the results of bounds tests approach can provide important insights into the relationship between money demand and financial variables in Malaysia.

The rest of the paper is organised as follows: Section 2 reviews the relevant literature. Section 3 describes econometric methodology. Section 4 reports and discusses the empirical model results. Finally, Section 5 summarises the conclusions and policy implications.

2. Literature Review

In the literature, a number of studies have attempted to model the effect of foreign monetary developments on domestic money demand by including foreign monetary variables. In this regard, several researchers (Hamburger (1977) for Germany and the United Kingdom; Arango and Nadiri (1981) for Canada, Germany, the U K and the US; El-Badawi and Domowitz (1987) for Sudan; Bahmani-Oskooee (2001) for the US, Japan and Thailand; McNown and Wallace (1992) for the US; Darrat and Al-Mutawa (1996) for the United Arab Emirates; Hueng (1998) for Canada; James (2005) for Indonesia; and Bjørnland (2005) for Venezuela) included foreign monetary variables in addition to the traditional real income/output and interest rate variables in their money demand functions. However, their findings were characterised by a wide range of differences. A number of factors such as specification problems or use of exchange rate data of the fixed exchange rate periods were blamed for the unexpected results.

For example, Hamburger (1977) analysed this relationship by employing different measures of foreign interest rates to see whether they could be considered for inclusion as possible opportunity costs of holding domestic money. Surprisingly, only the coefficient of domestic interest rate was statistically significant although domestic and foreign interest rates moved together. Hamburger justified this finding by arguing that "if (the domestic rate) and (the foreign interest rate) are included in the same equation, only the coefficient of the former remains statistically significant" (p.31). In the same direction, Arango and Nadiri (1981) included both the exchange rate and the foreign interest rate in addition to the usual variables and found that the coefficients of the level of exchange rates were statistically significant in each case, prompting the conclusion that the 'rebalancing effect' of exchange rate changes does affect demand for real cash balances. Similarly, Bahmani-Oskooee and Malixi (1991) arrived at the same conclusion as Hamburger did, concluding that exchange rate should be included in the money demand estimation only when the exchange rates are under a floating system.

In agreement with Bahmani-Oskooee and Malixi (1991), however, Hueng (1998) considered the findings of Hamburger (1977) and Arango and Nadiri (1981) to be flawed for using the data from the fixed exchange rate period, arguing that the insignificance of the coefficients of the foreign monetary variables in their results could be attributed to the relative stability under the fixed exchange rate system. Hueng charged that the studies failed to provide a theoretical model to justify the specifications of the empirical money demand function. In his estimation of an open-economy money demand function for Canada in which he constructed a cash-in-advance model, Hueng included both the domestic and foreign interest rates in addition to real income and real exchange rate. The estimated coefficients on the two interest rates carried expected positive and negative signs respectively, consistent with the comparative static of the model. According to Hueng, the negative sign of the coefficient on the domestic interest rate implies that an increase in the domestic interest rate raises the opportunity cost of holding money, thereby lowering the demand for it. On the other hand, the positive effect on foreign interest rate on money demand indicates that, since domestic and foreign moneys are imperfect substitutes for one another, the demand for domestic money would increase as the opportunity cost of holding foreign currency increases. Interestingly, Hueng found the effect of real exchange rate on domestic money demand to be negative, arguing that a depreciation of domestic currency is associated with a decrease in the demand for money, hence, offsetting the positive effect generated by the increase in foreign demand of domestic money. Hueng asserted that a depreciation of real exchange rate reduces the rate of return to foreign residents holding domestic bonds, hence, raising the demand for domestic money.

3. The Estimation Methodology

The traditional view that dominated money demand literature in the past that the long-run demand for money is positively related to the price level and income and/or wealth and negatively to its opportunity cost, the own interest rate(s) has been challenged on the grounds that it ignores the importance of foreign monetary developments on domestic demand for money.[1] The implicit relationship between money demand and exchange rate was first observed when Mundell (1963) noticed that the demand for money could depend on exchange rate in addition to the usual traditional determinants such as real income and interest rate. The belief was that the sensitivity of the demand for money to the level of exchange rate was an important factor in determining the relative effectiveness of both monetary and fiscal policies. This sensitivity could reduce the relative effectiveness of monetary policy while enhancing the fiscal one. This underlines the important fact that the effects of monetary developments in one country can inevitably spill over into other countries' domestic monetary system. In addition, the important role of foreign interest rates on domestic economy has been pointed out. Hueng (1998: 15) notes that "if peoples' holdings of money change with foreign monetary developments, such as the foreign interest rate and the exchange rate, the isolation mechanism of the floating exchange rate system will break down."

Following the Mundell conjecture, it has become commonplace to add foreign monetary variables such as foreign interest rate and foreign exchange rate to the other domestic variables when estimating the money demand function. In that respect, Hamburger (1977), Arango and Nadiri (1981), Hueng (1998) and others have specified the money demand as

$$M^d / P = f(Y_t, E_t, R, R^*) \tag{1}$$

where M^d denotes demand for nominal money balances; P represents the price level; Y is a scale variable (income, wealth, expenditure, in real terms); E is nominal exchange rate, and R and R^* are domestic and foreign interest rates respectively. The above specification, which represents the long-run real money demand function, assumes a long-run unitary elasticity of the nominal cash balances with respect to the price level. If we assume log-linearity, then real money demand function can be written in the following alternative form:

[1] See, for example, Hamburger (1977), Arango and Nadiri (1981), McNown and Wallace (1992).

$$m_t = \beta_0 + \beta_1 y_t + \beta_2 q_t + \beta_3 R_t + \beta_4 R_t^* + \varepsilon_t \quad (2)$$

where the lower-case letters represent the logarithm of variables. The expected signs for the β_i's are $\beta_1>0$, or $\beta_1 = 1$ for the quantity theory or $\beta_1 = 0.5$ for the economies of scale, $\beta_2>0$ or <0, $\beta_3<0$ and $\beta_4>0$. In this connection, real exchange rate is defined as $q = e.P^*/P$ in which an increase in e would denote a depreciation of the domestic real exchange rate and vice-versa. For given values of the right side variables and their long-run impact on money demand (i.e., the β_i), the equilibrium relationship is such that money demand is at m^d assuming real money demand adjusts instantaneously to real money supply.[2]

Estimating and interpreting long-run cointegrating vectors which may include $I(0)$ and $I(1)$ variables has often presented researchers with some paramount difficulties. For this reason, Pesaran *et al.* (2001) developed the bounds testing technique within an autoregressive distributed lag framework (thereafter ARDL). In addressing this problem, Pesaran and Pesaran (1997) and Pesaran *et al.* (2001) considered the following general traditional ADRL $(p, q_1, q_2, \ldots, q_k)$ form:

$$\phi\,(L, p)y_t = \alpha_0 + \sum_{i=1}^{k} \beta_i\,(L, q_i)\, x_{it} + \delta\,'_{wt} + \mu_t \quad (3)$$

where $\phi(L,p) = 1 - \sum_{j=1}^{p} \phi_j L^j$ and $\beta_i(L,q_i) = \sum_{j=0}^{q} \beta_j L^j$, $i = 1, 2, \ldots, k.$

L is a lag operator such that $Ly_t = y_{t-1}$ and w_t is an s x 1 vector of deterministic variables such as seasonal dummies, time trends, or exogenous variables with fixed lags, and the disturbance term, μ_t, is $iid(0, \sigma^2_\mu)$. In this case, y_t is the vector of dependent variables, α_0 is vector of constant terms; x_t is the k-dimensional $I(1)$ independent variables that are not cointegrated among themselves where $i = 1, 2, \ldots, k$. Equation (3) is first estimated by the OLS method for all possible values of p for a total of $(m + 1)^{k+1}$ different ARDL models using appropriate technique for choosing the maximum lag. In the second stage, the researcher selects one of the $(m + 1)^{k+1}$ estimated models. The long-run model that includes the constant term is written as

$$y_t = \alpha_0 + \sum_{i=1}^{k} \beta_i x_i + \delta\,' w_t v_t \qquad \phi = \frac{\alpha_0}{\phi\,(1,p)} \quad (4)$$

The long-run coefficients for the response of y_t to a unit change in x_t are estimated by

$$\beta_i = \frac{\hat{\beta}_i\,(1, \hat{q}_i)}{\hat{\phi}\,(1, \hat{p})} = \frac{\hat{\beta}_{i0} + \hat{\beta}_{i1} + \ldots + \hat{\beta}_{i\hat{q}}}{1 - \hat{\phi}_1 - \hat{\phi}_2 - \ldots \hat{\phi}_{\hat{p}}}, \qquad i = 1, 2, \ldots k \quad (5)$$

where $\hat{p}$ and $\hat{q}_i = 1, 2, \ldots k$, are the estimated values of p and q_i, $i = 1, 2, \ldots k$.

[2] See for example Nachega (2001) for further discussion.

The error-correction representation of the ARDL $(\hat{p}, \hat{q}_1, \hat{q}_2..\hat{q}_K)$ can be derived from rewriting Equation (3) in terms of the lagged levels and first differences of both the endogenous and independent variables and the deterministic terms as follows:

$$\Delta y_t = \Delta\alpha_0 - \sum_{j=1}^{\hat{p}-1}\phi^*_j \Delta y_{t-j} + \sum_{i=1}^{\kappa}\beta_{i0}\Delta x_{it} - \sum_{i=1}^{\kappa}\sum_{j=1}^{\hat{q}_i-1} \beta^*_{ij}\Delta x_{it-j} + \delta^{\prime}\Delta w_t \tag{6}$$
$$-\phi(1,\hat{p})\, ECT_{t-1} + \mu_t$$

where ECT is the error-correction term, defined by $ECT = y_t - \hat{\alpha} - \sum_{i=1}^{\kappa}\hat{\beta}_t x_{it} - \delta^{\prime} w_t$, ϕ^*_j, β^*_{ij} and $\delta^{\prime}$ are the coefficients that measure the short-run dynamics of the model's convergence to equilibrium while $\phi\,(1, p)$ captures the speed of adjustment that restores the long-run equilibrium.

If the theory predicts that real money, real domestic output, real exchange rate, domestic and foreign interest rates in Equation (2) are cointegrated, the model can be estimated in the following unrestricted error-correction (UEC) log-linear form, making each of the five variables in the system in turn as a dependent variable:

$$\Delta \ln m_t = \alpha_{0M} + \sum_{i=1}^{n}\beta_{im}\Delta \ln m_{t-i} + \sum_{i=0}^{n}\chi_{im}\Delta \ln y_{t-i} + \sum_{i=0}^{n}\delta_{im}\Delta \ln q_{t-i} + \sum_{i=0}^{n}\gamma_{im} R_{t-i} + \sum_{i=0}^{n}\eta_{im} R^*_{t-i}$$
$$+ a_{1m} m_{t-1} + b_{2m}\, y_{t-1} + c_{3m}\, q_{t-1} + d_{4m} R_{t-1} + e_{5m} R^*_{t-1} + \varepsilon_{1t} \tag{7a}$$

$$\Delta \ln y_t = \alpha_{0y} + \sum_{i=1}^{n}\beta_{iy}\Delta \ln m_{t-i} + \sum_{i=0}^{n}\chi_{iy}\Delta \ln y_{t-i} + \sum_{i=0}^{n}\delta_{iy}\Delta \ln q_{t-i} + \sum_{i=0}^{n}\gamma_{iy} R_{t-i} + \sum_{i=0}^{n}\eta_{iy} R^*_{t-i}$$
$$+ a_{1y} m_{t-1} + b_{2y}\, y_{t-1} + c_{3y}\, q_{t-1} + d_{4y} R_{t-1} + e_{5y} R^*_{t-1} + \varepsilon_{1t} \tag{7b}$$

$$\Delta \ln q_t = \alpha_{0E} + \sum_{i=1}^{n}\beta_{iE}\Delta \ln m_{t-i} + \sum_{i=0}^{n}\chi_{iE}\Delta \ln y_{t-i} + \sum_{i=0}^{n}\delta_{iE}\Delta \ln q_{t-i} + \sum_{i=0}^{n}\gamma_{iE} R_{t-i} + \sum_{i=0}^{n}\eta_{iE} R^*_{t-i}$$
$$+ a_{1q} m_{t-1} + b_{2q}\, y_{t-1} + c_{3q}\, q_{t-1} + d_{4q} R_{t-1} + e_{5q} R^*_{t-1} + \varepsilon_{1t} \tag{7c}$$

$$\Delta R_t = \alpha_{0iF} + \sum_{i=1}^{n}\beta_{iiF}\Delta \ln m_{t-i} + \sum_{i=0}^{n}\chi_{iiF}\Delta \ln y_{t-i} + \sum_{i=0}^{n}\delta_{iiF}\Delta \ln q_{t-i} + \sum_{i=0}^{n}\gamma_{iiF} R_{t-i} + \sum_{i=0}^{n}\eta_{iiF} R^*_{t-i}$$
$$+ a_{1R} m_{t-1} + b_{2R}\, y_{t-1} + c_{3R}\, q_{t-1} + d_{4R} R_{t-1} + e_{5R} R^*_{t-1} + \varepsilon_{1t} \tag{7d}$$

$$\Delta R^*_t = \alpha_{0iD} + \sum_{i=1}^{n}\beta_{tR^*}\Delta \ln m_{t-i} + \sum_{i=0}^{n}\chi_{iR^*}\Delta \ln y_{t-i} + \sum_{i=0}^{n}\delta_{iR^*}\Delta \ln q_{t-i} + \sum_{i=0}^{n}\gamma_{iR^*} R_{t-i} + \sum_{i=0}^{n}\eta_{iR^*} R^*_{t-i}$$
$$+ a_{1R^*} m_{t-1} + b_{2R^*}\, y_{t-1} + c_{3R^*}\, q_{t-1} + d_{4R^*} R_{t-1} + e_{5R^*} R^*_{t-1} + \varepsilon_{1t} \tag{7e}$$

After establishing the existence of a long-run relationship, the F-statistic identifies on which variable to normalise. The null hypothesis of no cointegration among the variables in the money equation (7a) is implied by the null hypothesis: $a_{1m} = b_{2m} = c_{3m} = d_{4m} = e_{5m} = 0$ against the alternative: $a_{1m} \neq b_{2m} \neq c_{3m} \neq d_{4m} \neq e_{5m} \neq 0$. The null hypothesis of no cointegration in the money demand equations (7b), (7c), (7d) and (7e) can be tested in a similar manner.

The underlying statistic is the usual Wald or *F*-statistic in a generalised Dickey-Fuller type of regression used for testing the significance of lagged levels of the variables under consideration in a continual unrestricted equilibrium correction model (ECM). Although the asymptotic distributions of both statistics are non standard under the null of no cointegration in levels among the variables, regardless of whether the regressors are purely $I(0)$, purely $I(1)$, or mutually cointegrated, Pesaran *et al.* (2001) established the consistency of the proposed test by deriving the test asymptotic distribution under the null of alternatives for a set of regressors which are a mixture of $I(0)$ and $I(1)$ variables. The test sets two asymptotic critical values for the two extreme cases which assume that all the regressors, on the one hand, are purely $I(1)$ and, on the other, purely $I(0)$. The test postulates three possible outcomes: (1) If the computed *F*-statistic falls above the upper critical value bounds, the null of no cointegration is rejected in favor of cointegration, irrespective of the integration/cointegration status of the underlying regressors; (2) if the statistic falls below the lower bound, then there is no cointegration among the variables; and (3) if the statistic falls inside the bounds, the test result is inconclusive and as a result, the researcher would need to know the order of integration before making any further conclusions.

4. The Empirical Results

4.1 Data Description

The empirical analysis was carried out on quarterly data on domestic money supply (M2), domestic output (GDP), nominal exchange rates (E), domestic interest rates (R_t) and foreign (US) interest rates (R_t^*)over the period 1991-2005. The data were obtained from the IMF International Finance Statistics (IFS) database. Money, domestic output and real exchange rates were measured in real terms using the consumer price indices (2000 = 100) as the deflators. Real exchange rate (q) was computed as a ratio of the product of nominal exchange rate and foreign price index to the domestic consumer price index ($q = e.P^*/P$) so that a rise in q would imply depreciation of the domestic currency. With the exception of interest rates, all the variables are in log form.

4.2 Bounds Test results

As the application of the bounds test (Pesaran *et al.* 2001) approach for cointegration test does not necessarily require pre-testing the underlying series for unit root, we performed the bounds test of cointegration among real money, real output, real exchange rate, domestic and foreign interest rates. For Equation (7a), the calculated *F*-statistic for testing the joint null hypothesis of no cointegration between real money demand and the specified independent variables, $F(m|y, q, R, R^*)$, is 4.1368. Since this value lies above the upper bound of the critical value band of 4.049 at 5 per cent level, the null of no long-run relationship among the variables is rejected at that significance level, irrespective of the order of their integration.

However, when real output, real exchange rate, domestic interest rates or foreign interest rates were, in turn, the dependent variables, the calculated *F*-statistics, 1.1021, 1.8778, 0.7911 and 0.6042, fell below the lower bound of the critical value band at any level of significance, suggesting no cointegration among the variables. Thus, the results indicate the existence of a single and unique cointegration relation among the variables only when

Table 1: Results of bounds test of cointegration

Critical value bounds of the *F*-statistic with intercept and no trend						
	90% level		95% level		99% level	
	$I(0)$	$I(1)$	$I(0)$	$I(1)$	$I(0)$	$I(1)$
	2.2425	3.574	2.850	4.049	3.817	5.122
Calculated *F*-statistic						
$F(m\|y, q, R, R^*)$		4.1369	[0.012]			
$F(y\|m, q, R, R^*)$		1.1021	[0.395]			
$F(q\|m, y, R\ R^*)$		1.8778	[0.151]			
$F(R\|m, y, q, R^*)$		0.7911	[0.571]			
$F(R^*\|m, y, q, R)$		0.6042	[0.698]			

Note: The critical values were computed by Pesaran *et al.* (2001). Figures in squared parentheses are *p*-values.

real money is the dependent variable in the Malaysian money demand model and that domestic real output, real exchange rates, domestic and foreign (US) interest rates could be considered as the 'long-run' forcing variables for the explanation of real money demand in Malaysia across the study period.

4.3 Long-run Autoregressive Distributed Lag (ARDL) Estimation Results

After establishing a long-run relationship among real money, real output, real exchange rate and domestic and foreign interest rates, we can proceed to estimate Equation (2) in the following ARDL (*n, p, q, r, s*) specification

$$1\text{n}\ m_t = \alpha_0 + \sum_{i=0}^{n} \alpha_1\ 1\text{n}\ m_{t-i} + \sum_{i=0}^{p} \alpha_2\ 1\text{n}\ y_{t=i} + \sum_{I=0}^{q} \alpha_3\ 1\text{n}q_{t-i} + \sum_{i=0}^{r} \alpha_4\ R_{t-i} + \sum_{i=0}^{s} \alpha_4\ R^*_{t-i} + \mu_t \quad (8)$$

The results of long-run ARDL and FMOLS are reported in Table 2. In both models, the results are consistent with the theoretical expectations, with all the coefficients carrying correct expected signs, as the theory would predict. In the first place, both models concurrently indicate that the coefficient of real income is statistically significant at 1 per cent level and correctly positive which is consistent with theory. However, the value of the estimated income elasticity of money demand is greater than 1 in both models, which is inconsistent with the hypothesis of economies of scale in money holding predicted by the transactions and precautionary theories. In this regard, Hueng (1998) argued that such a high value could be due to the use of a broader definition of money as is the case in this study. Secondly, the coefficient of real exchange rate is significant only in the FMOLS model but insignificant in the ARDL model. Considering the findings of the FMOLS model, this implies that depreciation of domestic currency will cause wealthholders to demand more real money balances in the long run, which is consistent with the theory. Thirdly, in both models, domestic interest rates do not affect the demand for real money in the long run in Malaysia. This should not be surprising since nominal exchange rates have been virtually fixed since September 1998. However, the coefficient of foreign (US) interest rate is significant and carries a correct positive sign, as the theory would expect. Like in Hueng's findings, the

Table 2: Results of the long-run money demand equation using autoregressive distributed lag ARDL (2, 2, 2, 4, 0) and FMOLS models

Regressors	ARDL (2, 2, 2, 4, 0)			FMOLS		
	Coefficient		*p*-values	Coefficients		*p*-values
Constant	-3.2552**	[-6.2675]	0.000	-3.2540**	[-9.1901]	0.000
y	1.6517**	[19.9345]	0.000	1.6244**	[28.9421]	0.000
q	0.1491	[1.3745]	0.329	0.2367**	[2.8244]	0.005
R	0.0044	[0.5338]	0.641	-0.0062	[-1.0451]	0.301
R^*	0.01131*	[2.0527]	0.047	0.02032**	[4.6397]	0.000
SR1				0.0793**	[6.3025]	0.000
SR2	-0.0687*	[-2.6773]	0.011			
SR3				-0.0615**	[-5.0508]	0.000

Note: (**) and (*) refer to statistical significance level at 1 per cent and 5 per cent respectively. Figures in squared brackets denote *t*-statistics. SR1, SR2 and SR3 refer to the dummy variable for the first, second and third quarter, respectively.

positive semi-elasticty of foreign interest rate with respect to money demand indicates that since domestic and foreign moneys are imperfect substitutes for one another, the demand for domestic money would increase as the opportunity cost of holding foreign currency increases. In other words, a rise in foreign (US) interest rates would encourage domestic residents to demand more domestic real money balances in the long run in Malaysia.

In corroboration with the findings by Hueng (1998), the absolute value of the foreign interest rate elasticity is higher than that of domestic interest rate elasticity, suggesting that the long-run demand for M2 in Malaysia responds much faster to foreign interest rate than to domestic interest rate. This should not be surprising particularly in these fast-growing East Asian economies that depend, to some extent, on foreign capital. However, since capital mobility requires necessary adjustments in both the domestic and foreign interest rates, this adjustment then provides the link through which foreign financial developments can play a significant role in the domestic economy. Additionally, while the second season dummy is significant at least at 5 per cent significance level, the first and third seasonal dummies are statistically significant at 1 per cent level.

To check whether the estimation regression equations were stable during the study period, we plot the CUSUM and CUSUM of squares tests (Brown *et al.* 1975) as shown in Figures 1 and 2. The importance of these tests is that a movement of the CUSUM and CUSUM squared residuals outside the critical lines is suggestive of the instability of the estimated coefficients and parameter variance over the sample period. In both the figures, the statistics fall inside the 5 per cent critical lines, implying that regression equations are correctly specified and no systematic changes have occurred in the regression coefficients across the study period.

4.4 Estimates of Error Correction Representation for the Selected ARDL Model

Since we established the existence of a long-run relationship among the variables, we can estimate Equations (7a-7d) by including error correction terms as independent variables. This is because tests involving differenced variables can be mis-specified and some important information may be lost if the variables are cointegrated. This problem can be avoided only

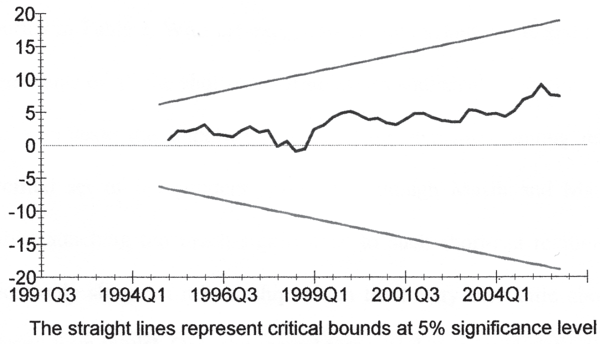

Figure 1: *Plot of cumulative sum of recursive residuals (CUSUM)*

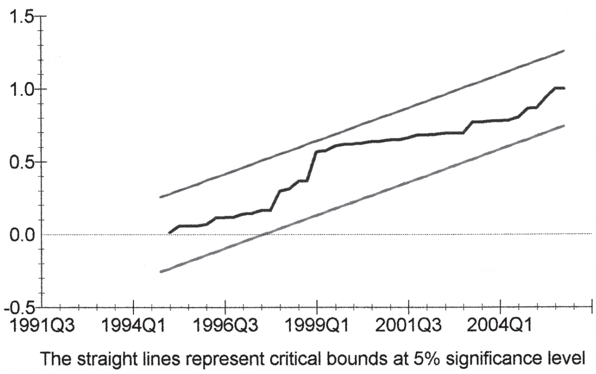

Figure 2: *Plot of cumulative sum of squares of recursive residuals (CUSUMSQ)*

when lagged error-correction terms (ECTs), derived from long-run cointegrating vectors, are included as independent explanatory variables in the estimation process of Equations (7a-7d).

The results of the error-correction model associated with these long-run estimates are reported in Table 3. With the exception of real exchange rate and foreign (US) interest rates, the coefficients of all the short-run variables are statistically significant at least at 5 per cent level. These results indicate the importance of short-run dynamics among real money demand, and the specified set of independent variables, although Masih and Masih (2004: 597) cautioned against attaching too much significance to such short-run relationships. This is because they reflect only on short-run relationships which the theory says little about as they are derived from reduced-form model. Only the second seasonal dummy is statistically significant at the 1 per cent level. The underlying short-run ADRL equation also passes all the diagnostic tests that are automatically computed by *Microfit* software such as the Durbin-Watson, which is close to 2, and the significant *F*-test.

Table 3: Error correction representation for the selected ARDL model (2, 2, 0, 1, 0)

Results of the slected error-correction model			
Regressor	Coefficient	*t*-statistics	*p*-values
$\Delta\ ln\ m2(-1)$	0.3511*	3.0872	0.003
$\Delta\ ln\ y$	0.4802**	5.1505	0.000
$\Delta\ ln\ y(-1)$	-0.5999**	-4.7278	0.000
$\Delta\ ln\ q$	0.0017	0.0398	0.968
$\Delta\ ln\ q(-1)$	-0.1206**	-3.6569	0.001
ΔR	-0.0159**	-3.0534	0.004
ΔR^*	0.0023	1.0040	0.321
SR2	-0.0272**	-3.8834	0.000
ECT(-1)	-0.2582**	-4.1711	0.000
R-square	0.5835		
Durbin-Watson stat.	2.2699		
F-Stat. F(9, 41)	7.3540		

Note: (**) and (*) refer to 1 per cent and 5 per cent level of significance. SR2 is the dummy variable for the second quarter.

The error-correction term that represents the proportion by which a long-run disequilibrium in the dependent variable can be corrected in each short-run period is statistically significant at 1 per cent level and correctly signed, suggesting that approximately 26 per cent of total disequilibrium in real money demand was being corrected in each quarter in Malaysia during the period of study. Our calculation in this study indicates that the implied half-life is approximately 2.3 quarters and takes approximately 3.9 quarters to completely dissipate any disequilibrium in real money demand in Malaysia during the study period.

5. Conclusions and Policy Implications

This paper estimates the effect of financial variables in addition to the traditional domestic determinants on money demand in Malaysia. The study employs the bounds testing approach to cointegration test (Pesaran 1997; Pesaran *et al.* 2001) in addition to the fully modified ordinary least squares (Phillips and Hansen 1990) on quarterly data covering the period 1991-2005.

The findings generally confirm the existence of both the long-run and short-run relationships among the variables. First, both models concurrently indicate that the coefficient of real income is statistically significant at 1 per cent level and correctly positive which is consistent with theory. Additionally, the value of the estimated income elasticity of money demand is greater than 1, which is inconsistent with the hypothesis of economies of scale in money holding predicted by the transactions and precautionary theories. Second, the coefficient of real exchange rate is significant only in the FMOLS model although it is insignificant in the ARDL model. Third, in both models, domestic interest rates do not affect the demand for real money in the long run in Malaysia. However, the coefficient of foreign (US) interest rate is significant and carries a correct positive sign according to the theory. Fourth, the results of the error-correction model associated with these long-run estimates indicate that, with the exception of real exchange rates and foreign (US) interest rates, the coefficients of all the short-run variables are statistically significant at least at 5 per cent level. Finally, the error-correction term is significant at 1 per cent level and correctly negatively signed, suggesting that approximately 26 per cent of total disequilibrium in real money demand was being corrected in each quarter in Malaysia across the study period.

The most important implication of the findings of this study is the reaffirmation of the existence of both the long-run and short-run relationships among the variables. More importantly, real demand for money is significantly affected by domestic real output and foreign (US) interest rates in the long run in Malaysia. As the results have reaffirmed the importance of foreign monetary developments, policy makers may need to consider the influence of foreign interest rates on domestic money demand rather than focusing only on domestic variables when formulating a stable and predictable monetary policy in both short-and long-runs in Malaysia.

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